3. EXISTING NORTHERN GOVERNORATES WATER SYSTEM

3.1 General

This study is intended to identify facilities that will alleviate the problems and constraints within the existing NGWA water supply system, as well as the requirements to meet the long-term growth in water demands. The purpose of this section is to summarize the existing conditions, and the work accomplished on this study in hydraulic network analysis of the existing system.

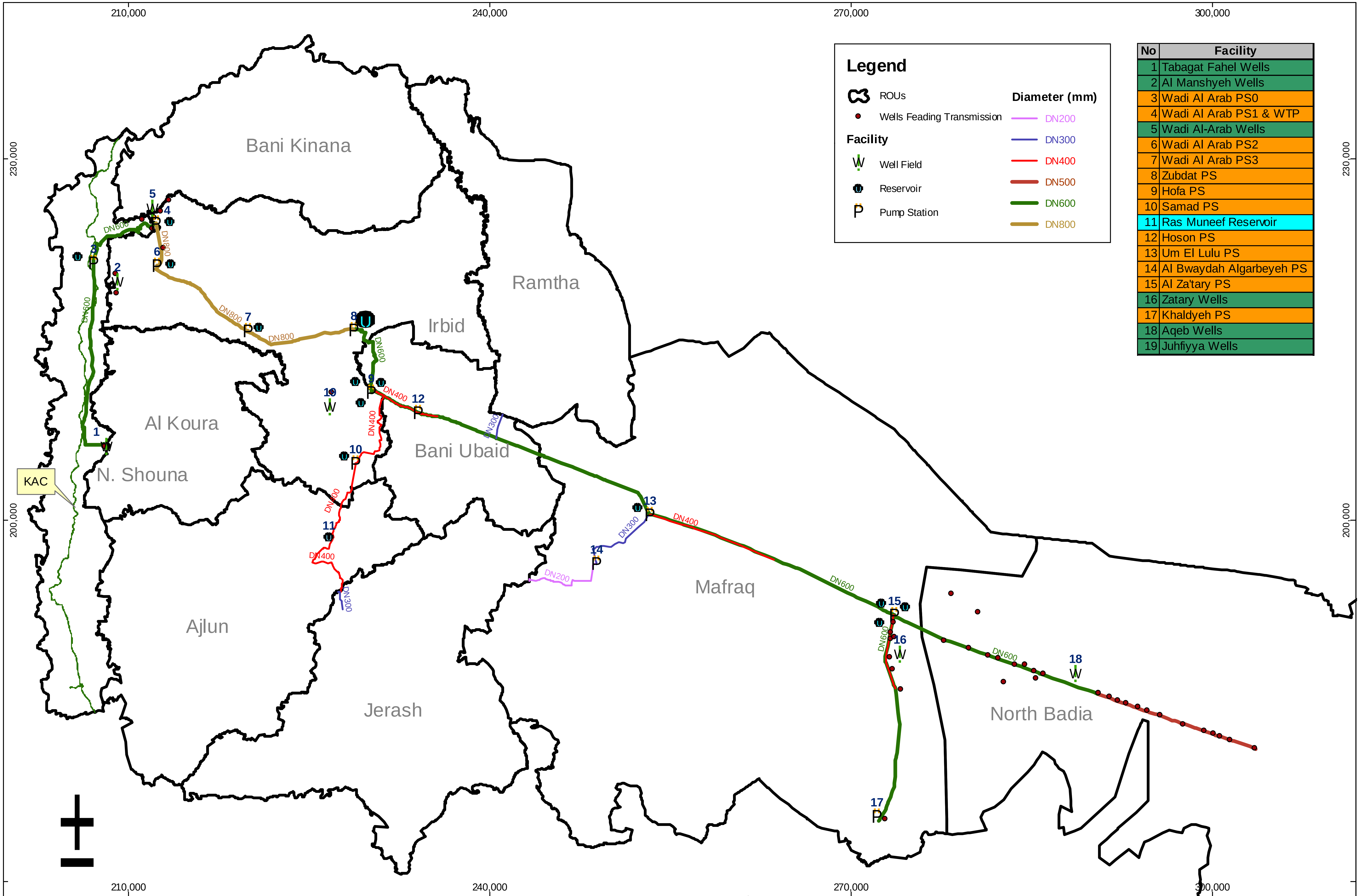
In general, NGWA is faced with a shortage of water and pipe capacity that requires rationing of water to customers, with many of them receiving water only one or two days per week. The NGWA system contains a backbone of sources and transmission pipes that serve numerous local distribution networks, but the historic development of the local distribution networks has been somewhat haphazard, and the local networks were built to a low standard that has resulted in high levels of leakage. The SOGREAH and SAFEGE hydraulic-analysis studies (completed in 1998) found that many of the small distribution lines are above ground and hence susceptible to damage and tampering. The rationing of water is intended not only to ration the limited available supply, but to limit the physical leakage from the system, that would be greater under conditions of continuous supply. It is unfortunate that when the SOGREAH and SAFEGE plans for rehabilitation and restructuring were completed in 1998, funds were not available to design and implement the plans.

3.2 Historical Development and Current Status

The existing transmission system and major well fields are shown on **Figure 3-1**. Operations are decentralized into the East and West transmission systems, and into 10 ROUs (Regional Operations Units) that take care of the local distribution networks. Irbid governorate is divided into 6 ROUs (Irbid, Al Koura, Bani Kanana, Bani Ubaid, North Shouna and Ramtha), Mafraq has 2 ROUs (Mafraq and North Badia), while Ajlun and Jerash each have one ROU.

The oldest portions of the East transmission system were first built about 1940, to carry water from the Zatary and Aqeb well fields. A major portion of the water produced from these well fields is exported to the Amman and Zarqa water supply systems. The major pumping and storage facilities at Zatary Pump Station were built in about 1938, and have been modified and expanded over the years (when new pipelines were added in 1975-1985). Pumps installed in 1938 have been carefully maintained, and remain in operation to this day. Currently the East transmission system serves the ROUs of North Badia, Mafraq, and portions of Jerash.

The West transmission system was developed in the mid-1980s, and carries water from the Wadi Al Arab, Tabagat Fahel and Manshyeh well fields to a major storage facility in Irbid (Zubdat Farkouh Reservoir, with a volume of 110,000 m^3). Pumping heads are very high within this system. Two well fields are pumped from below sea level at the Wadi Al Arab PS0, to join the flows from the Wadi Al Arab well field at the Wadi Al Arab water treatment plant. From here the flows are pumped successively at PS1, PS2 and PS3 to reach the Zubdat reservoir in Irbid; all these pump stations operate at hydraulic heads of about 200m.



No	Facility
1	Tabagat Fahel Wells
2	Al Manshyeh Wells
3	Wadi Al Arab PS0
4	Wadi Al Arab PS1 & WTP
5	Wadi Al-Arab Wells
6	Wadi Al Arab PS2
7	Wadi Al Arab PS3
8	Zubdat PS
9	Hofa PS
10	Samad PS
11	Ras Muneef Reservoir
12	Hoson PS
13	Um El Lulu PS
14	Al Bwaydah Algarbeyeh PS
15	Al Za'tary PS
16	Zatary Wells
17	Khaldyeh PS
18	Aqeb Wells
19	Juhfiyya Wells

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Existing Transmission System Layout

PROJECT No. 3029-42324

FIGURE No. 3-1

The major pump stations (PS0, PS1, PS2, and PS3) have been recently expanded and rebuilt, with the new pumps installed in separate pump station structures. Wadi Al Arab WTP was built in the mid-1980s in the same time the Western System was built, the plant capacity is 2300m3/h and share the same site with PS1. The treatment process at Wadi Arab WTP comprise aeration, sedimentation filtration and disinfection.

The NGWA water supply is obtained from groundwater sources, of which water was produced from about 93 individual wells, springs, or well fields (groups of wells tied to a pump station) during 2003, as shown in **Table 3-1**. In total, there are about 200 individual wells or springs in the system. The water production from local wells operated by the ROUs in 2003 amounted to 27.6 MCM. The East and West transmission systems produced 22.7 and 19.8 MCM respectively.

Table 3-1 Internal Water Production, Imports and Exports, 2003

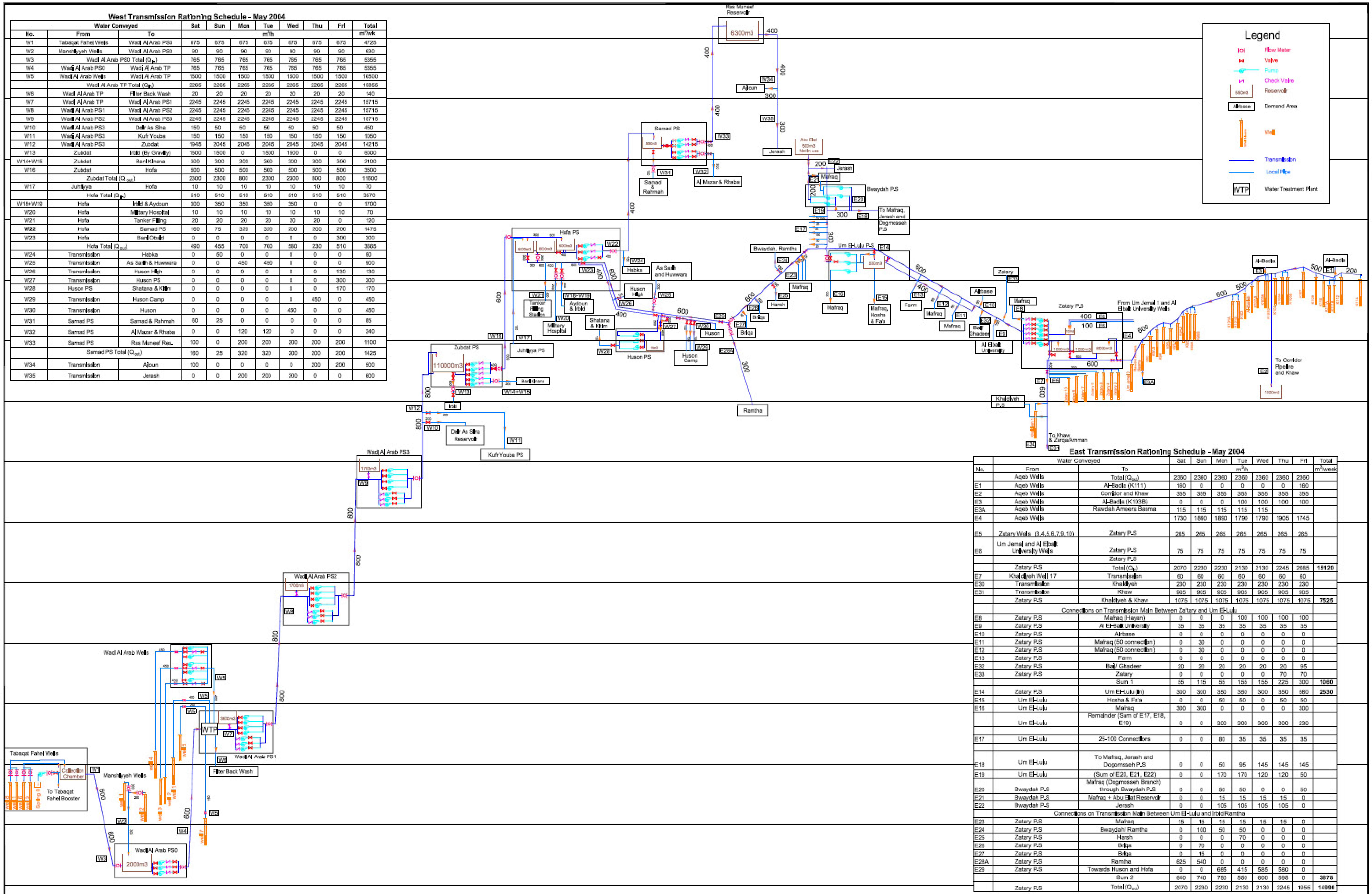
Gvrte.	ROU or System	Number of Water Sources: Operating/Total				Production in 2003		
		Single Wells	Springs	Well Fields	Total Sources	CM/Yr	CM/day	CM/hr
Ajlun	Ajlun	2 / 4	5 / 7	1 / 2	8 / 13	2,626,868	7,197	300
Irbid	Al Koura	2 / 4	0 / 0	2 / 2	4 / 6	2,651,783	7,265	303
Irbid	Bani Kanana	2 / 5	0 / 0	1 / 3	3 / 8	479,163	1,313	55
Irbid	Bani Ubaid	1 / 1	0 / 0	2 / 2	3 / 3	406,224	1,113	46
Irbid	Irbid	3 / 4	0 / 0	9 / 9	12 / 13	3,157,845	8,652	360
Irbid	North Shouneh	5 / 10	1 / 1	0 / 0	6 / 11	1,369,672	3,753	156
Irbid	Ramtha	7 / 7	0 / 0	5 / 6	12 / 13	1,582,391	4,335	181
Jerash	Jerash	4 / 9	3 / 7	4 / 5	11 / 21	2,711,481	7,429	310
Mafraq	Mafraq	4 / 9	0 / 0	6 / 7	10 / 16	7,159,874	19,616	817
Mafraq	North Badia	4 / 13	0 / 0	9 / 12	13 / 25	5,486,193	15,031	626
Subtotal, ROUs		**34 / 66**	**9 / 15**	**39 / 48**	**82 / 129**	**27,631,494**	**75,703**	**3,154**
East Transmission		0 / 4	0 / 0	3 / 3	3 / 7	22,666,026	62,099	2,587
West Transmission		6 / 10	0 / 0	2 / 2	8 / 12	19,776,635	54,183	2,258
Subtotal, Transmission		**6 / 14**	**0 / 0**	**5 / 5**	**11 / 19**	**42,442,661**	**116,281**	**4,845**
TOTAL, NGWA		**40 / 80**	**9 / 15**	**44 / 53**	**93 / 148**	**70,074,155**	**191,984**	**7,999**
Imports to NGWA						425,972	1,167	49
Exports from NGWA						-11,688,720	-32,024	-1,334
NET, NGWA						**58,811,407**	**161,127**	**6,714**

Bulk water meters at 50 locations are used to measure the water imported and exported, across the borders of the ROUs and the NGWA service area. Imports from outside NGWA are relatively small, amounting to 0.43 MCM in 2003: about 0.38 MCM was obtained from Zarqa to supply portions of Jerash and Mafraq; and about 0.05 MCM was obtained from Balqa to supply a portion of North Shouneh.

NGWA exported a substantial amount of water to Zarqa, amounting to 11.69 MCM in 2003: 8.04 MCM to Zarqa/Khaw at Khaldiyeh; 3.11 MCM to Zarqa/Khaw at the Corridor Wells (which serve Amman and Zarqa); and 0.54 MCM to Zarqa/Duliel at Khaldiyeh. Under previous agreements, all (or a portion of) these exports are to cease when the Amman-Zarqa supply systems obtain additional water upon completion of the Zara-Ma'in project.

3.3 Existing Transmission Systems and Networks

Figure 3-2 shows a profile of the existing transmission system, and the rationing schedule that applied in May 2004. It shows both the East and West components of the existing systems. The profile shows the elevations of the facilities in relation to each other, for the components shown previously in **Figure 3-1**.



West Transmission Rationing Schedule - May 2004

No.	From	To	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Total
	Water Conveyed		m³/h							m³/wk
W1	Tabaqat Fahel Wells	Wadi Al Arab PS0	675	675	675	675	675	675	675	4725
W2	Manshiyyeh Wells	Wadi Al Arab PS0	90	90	90	90	90	90	90	630
W3	Wadi Al Arab PS0 Total (Q_{in})		765	765	765	765	765	765	765	5355
W4	Wadi Al Arab PS0	Wadi Al Arab TP	765	765	765	765	765	765	765	5355
W5	Wadi Al Arab Wells	Wadi Al Arab TP	1500	1500	1500	1500	1500	1500	1500	10500
	Wadi Al Arab TP Total (Q_{in})		2265	2265	2265	2265	2265	2265	2265	15855
W6	Wadi Al Arab TP	Filter Back Wash	20	20	20	20	20	20	20	140
W7	Wadi Al Arab TP	Wadi Al Arab PS1	2245	2245	2245	2245	2245	2245	2245	15715
W8	Wadi Al Arab PS1	Wadi Al Arab PS2	2245	2245	2245	2245	2245	2245	2245	15715
W9	Wadi Al Arab PS2	Wadi Al Arab PS3	2245	2245	2245	2245	2245	2245	2245	15715
W10	Wadi Al Arab PS3	Deir As Sina	150	50	50	50	50	50	50	450
W11	Wadi Al Arab PS3	Kufr Youba	150	150	150	150	150	150	150	1050
W12	Wadi Al Arab PS3	Zubdat	1945	2045	2045	2045	2045	2045	2045	14215
W13	Zubdat	Irbid (By Gravity)	1500	1500	0	1500	1500	0	0	6000
W14+W15	Zubdat	Bani Kinana	300	300	300	300	300	300	300	2100
W16	Zubdat	Hofa	500	500	500	500	500	500	500	3500
	Zubdat Total (Q_{out})		2300	2300	800	2300	2300	800	800	11600
W17	Juhfiyya	Hofa	10	10	10	10	10	10	10	70
	Hofa Total (Q_{in})		510	510	510	510	510	510	510	3570
W18+W19	Hofa	Irbid & Aydoun	300	350	350	350	350	0	0	1700
W20	Hofa	Military Hospital	10	10	10	10	10	10	10	70
W21	Hofa	Tanker Filling	20	20	20	20	20	20	0	120
W22	Hofa	Samad PS	160	75	320	320	200	200	200	1475
W23	Hofa	Bani Obaid	0	0	0	0	0	0	300	300
	Hofa Total (Q_{out})		490	455	700	700	580	230	510	3665
W24	Transmission	Habka	0	60	0	0	0	0	0	60
W25	Transmission	As Sarih & Huwwara	0	0	450	450	0	0	0	900
W26	Transmission	Huson High	0	0	0	0	0	0	130	130
W27	Transmission	Huson PS	0	0	0	0	0	0	300	300
W28	Huson PS	Shatana & Kitim	0	0	0	0	0	0	170	170
W29	Transmission	Huson Camp	0	0	0	0	0	450	0	450
W30	Transmission	Huson	0	0	0	0	450	0	0	450
W31	Samad PS	Samad & Rahmah	60	25	0	0	0	0	0	85
W32	Samad PS	Al Mazar & Rhaba	0	0	120	120	0	0	0	240
W33	Samad PS	Ras Muneef Res.	100	0	200	200	200	200	200	1100
	Samad PS Total (Q_{out})		160	25	320	320	200	200	200	1425
W34	Transmission	Ajloun	100	0	0	0	0	200	200	500
W35	Transmission	Jerash	0	0	200	200	200	0	0	600

East Transmission Rationing Schedule - May 2004

No.	From	To	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Total
	Water Conveyed		m³/h							m³/week
	Aqeb Wells	Total (Q_{out})	2360	2360	2360	2360	2360	2360	2360	
E1	Aqeb Wells	Al-Badia (K111)	160	0	0	0	0	0	160	
E2	Aqeb Wells	Corridor and Khaw	355	355	355	365	355	355	355	
E3	Aqeb Wells	Al-Badia (K103B)	0	0	0	100	100	100	100	
E3A	Aqeb Wells	Rawdah Ameera Basma	115	115	115	115	115			
E4	Aqeb Wells		1730	1890	1890	1790	1790	1905	1745	
E5	Zatary Wells (3,4,5,6,7,9,10)	Zatary P.S	265	265	265	265	265	265	265	
E6	Um Jemal and Al Elbait University Wells	Zatary P.S	75	75	75	75	75	75	75	
		Zatary P.S								
	Zatary P.S	Total (Q_{in})	2070	2230	2230	2130	2130	2245	2085	15120
E7	Khaldiyeh Well 17	Transmission	60	60	60	60	60	60	60	
E30	Transmission	Khaldiyeh	230	230	230	230	230	230	230	
E31	Transmission	Khaw	905	905	905	905	905	905	905	
	Zatary P.S	Khaldiyeh & Khaw	1075	1075	1075	1075	1075	1075	1075	7525
	Connections on Transmission Main Between Za'tary and Um El-Lulu									
E8	Zatary P.S	Mafraq (Hayan)	0	0	0	100	100	100	100	
E9	Zatary P.S	Al El-Bait University	35	35	35	35	35	35	35	
E10	Zatary P.S	Airbase	0	0	0	0	0	0	0	
E11	Zatary P.S	Mafraq (50 connection)	0	30	0	0	0	0	0	
E12	Zatary P.S	Mafraq (50 connection)	0	30	0	0	0	0	0	
E13	Zatary P.S	Farm	0	0	0	0	0	0	0	
E32	Zatary P.S	Bair Ghadeer	20	20	20	20	20	20	95	
E33	Zatary P.S	Zatary	0	0	0	0	0	70	70	
		Sum 1	55	115	55	155	155	225	300	1060
E14	Zatary P.S	Um El-Lulu (In)	300	300	350	350	300	350	580	2530
E15	Um El-Lulu	Hosha & Fa'a	0	0	50	50	0	50	50	
E16	Um El-Lulu	Mafraq	300	300	0	0	0	0	300	
	Um El-Lulu	Remainder (Sum of E17, E18, E19)	0	0	300	300	300	300	230	
E17	Um El-Lulu	25-100 Connections	0	0	80	35	35	35	35	
E18	Um El-Lulu	To Mafraq, Jerash and Dogomsseh P.S	0	0	50	95	145	145	145	
E19	Um El-Lulu	(Sum of E20, E21, E22)	0	0	170	170	120	120	50	
E20	Bwaydah P.S	Mafraq (Dogmosseh Branch) through Bwaydah P.S	0	0	50	50	0	0	50	
E21	Bwaydah P.S	Mafraq + Abu Elat Reservoir	0	0	15	15	15	15	0	
E22	Bwaydah P.S	Jerash	0	0	105	105	105	105	0	
	Connections on Transmission Main Between Um El-Lulu and Irbid/Ramtha									
E23	Zatary P.S	Mafraq	15	15	15	15	15	15	0	
E24	Zatary P.S	Bwaydah/ Ramtha	0	100	50	50	0	0	0	
E25	Zatary P.S	Harsh	0	0	0	70	0	0	0	
E26	Zatary P.S	Briqa	0	70	0	0	0	0	0	
E27	Zatary P.S	Briqa	0	15	0	0	0	0	0	
E28A	Zatary P.S	Ramtha	625	540	0	0	0	0	0	
E29	Zatary P.S	Towards Huson and Hofa	0	0	685	415	585	580	0	
		Sum 2	640	740	750	580	600	595	0	3875
	Zatary P.S	Total (Q_{out})	2070	2230	2230	2130	2130	2245	1955	14890

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NORTHERN GOVERNORATES WATER TRANSMISSION SYSTEM FEASIBILITY STUDY

PROFILE OF THE FACILITIES IN THE EXISTING TRANSMISSION SYSTEM

PROJECT NO. 3029-42324

FIGURE NO. 3–2

The major water sources of the system are the Tabaqat Fahel wells and Wadi Al Arab wells in the west, and the Aqeb wells and Za'tary Wells in the east. The major facilities are numbered sequentially from west to east on **Figure 3-1**, and are described below in sequence.

Discharge from the Tabaqat Fahel wells is carried to a collection chamber at an elevation of 72m below sea level, then flows by gravity through a 600mm pipeline to a tank (designated as PS0) at an elevation of -190m. The Manshiyeh wells are also collected at Tank PS0 by gravity. The collected water in PS0 is pumped to Wadi Al Arab WTP (water treatment plant). Water from the Wadi Al Arab wells is also collected at the WTP. Treated water is discharged to a 3600m^3 storage tank at PS1 at the WTP at elevation 36m and pumped into an 800mm pipeline to PS2 at an elevation of 234m. The pipeline feeds a portion of the flow to the PS2 pumps, and passes the rest of the flow to a 1700m^3 tank. The PS2 pump station boosts water to PS3 at elevation 420m (which also contains a 1700m^3 tank). PS3 pumps the water to Zubdat reservoir (110,000m^3) which supplies most of Irbid city. The 800mm transmission line between PS3 and Zubdat reservoir along its way supplies Deir As Sina town and Kufr Youba town supplementing supplies from the local source Juhfiyya Wells.

Zubdat pump station pumps water to reservoirs at Hofa through a 600mm transmission line. It also pumps to Bani Kinana through a 200mm pipeline. Hofa reservoirs also receive a small amount of water (10m^3/h) from Juhfiyya. The Hofa reservoirs supply water in several directions to serve such areas as Aydoun, Military Hospital, As Sarih, and Hoson PS (through two parallel pipelines).

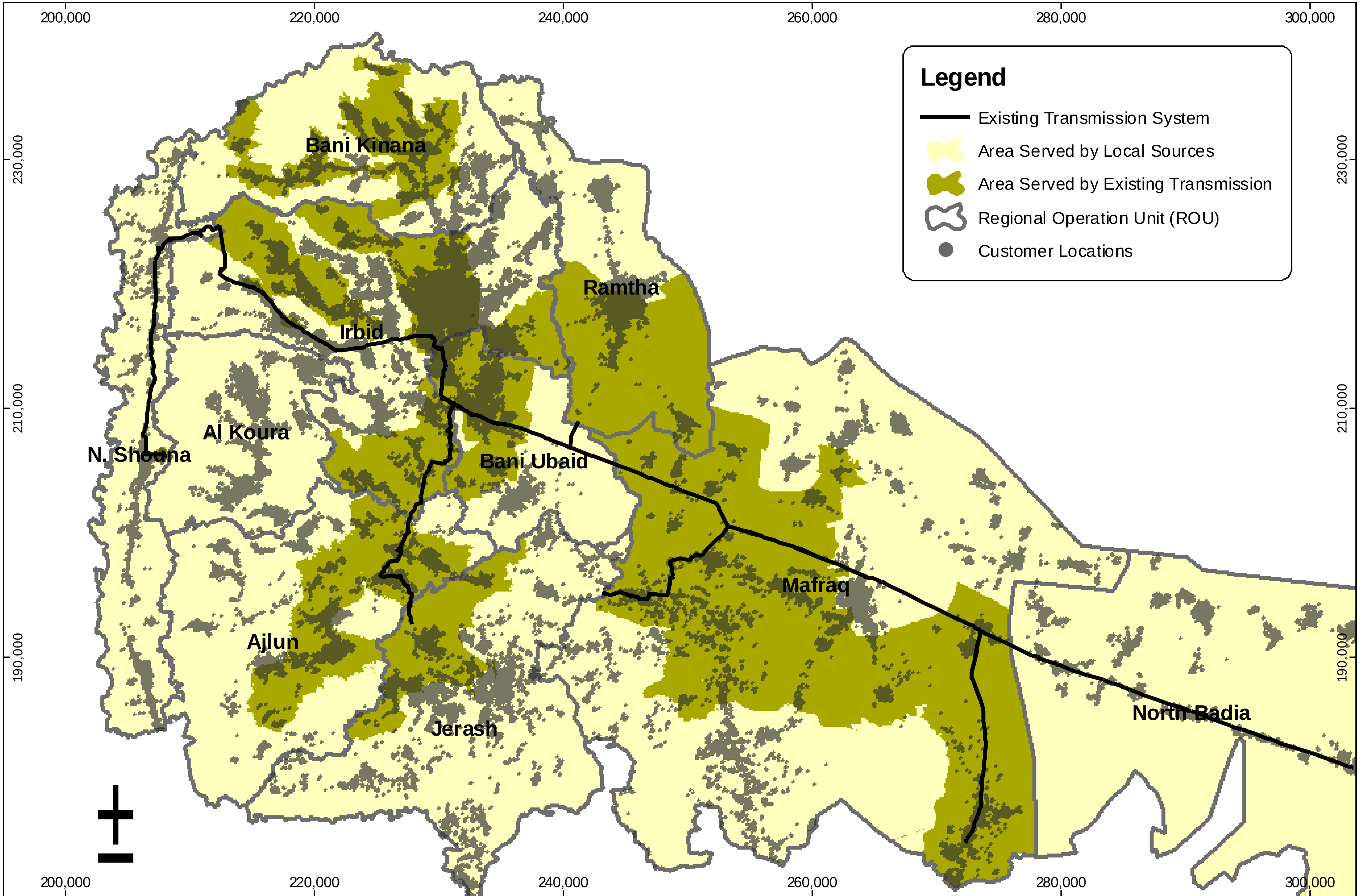
Hofa pump station conveys water to Samad tank at an elevation of 985m by a 400mm pipeline, after which the Samad pump station conveys water to Ras Muneef Reservoir at Elevation 1190m, which in turn supplies water to Ajlun and Jerash by gravity.

The Eastern part of the system comprises a collector pipeline which collects the discharge of 28 wells in Al Aqeb Well Field in the Badia highlands at elevations between 820 – 720m, and carries the flow to Za'tary PS at Elevation 655m. The 8000m^3 reservoir of Za'tary is fed from the 600mm collector transmission pipeline which also takes water by gravity to Khaldiyeh at Elevation 640m and thence to Khaw PS where it’s pumped to Zarqa and Amman.

In Al Za'tary there are three interconnected reservoirs, one tank of 8000 m^3 and two tanks of 1000 m^3 capacity each. One of the 1000m^3 tanks is fed by a 400mm collector pipeline that collects the discharge of Al Za'tary Well field. Also there is a small tank of 100m^3 capacity that collects the discharge of Um El Jemal well and Al Elbiat University wells. The pump station of Al Za'tary pumps through a 600mm transmission pipeline to Um El Lulu, feeding along its way many demand locations up to Zubdat reservoir

Um El Lulu PS is fed by a 200mm pipeline takeoff from the 600mm main transmission pipeline. The takeoff feeds a 550m^3 tank as well as the pump station, which boosts water to Al Bwaydah PS via a 300mm pipeline that feeds some demand points along its way. Al Bwaydah PS boosts to Mafraq and Abu Eiat in Jerash.

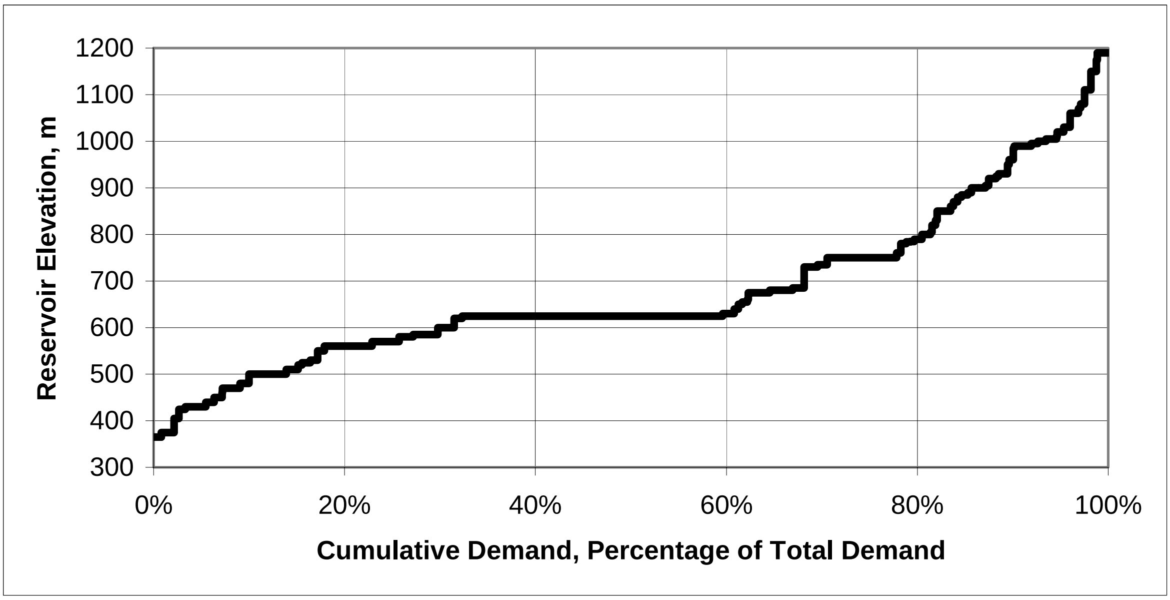
The transmission system, along its way, feeds many distribution zones in the east and west part. There are some isolated zones serving small communities which are fed by local resources rather than the transmission system; these zones are called "Resource Zones". **Figure 3-3** shows the areas supplied by the transmission system, and the remaining areas that are served by local water sources (springs or wells).



DRAWING SCALE: 1:400,000	THE HASHEMITE KINGDOM OF JORDAN MINISTRY OF WATER AND IRRIGATION WATER AUTHORITY	CDM CDM International Inc.	NORTHERN GOVERNORATES WATER TRANSMISSION SYSTEM FEASIBILITY STUDY Area Served by the Existing Transmission System	PROJECT No.: 3029-42324 FIGURE No. 3-3

Over time, the existing transmission system will be extended to serve about 124 water distribution reservoirs, which cannot be illustrated easily on a single profile, as in Figure 3-2. The large range in ground elevation for the customers to be served can best be illustrated by showing the water demands made on reservoirs, using the elevation of the reservoir as an indicator. In most cases, the ground elevations of customer premises lie 20m to 50m below the water level in the reservoir that serves them. The water demand on the transmission system, as a function of reservoir elevation, is shown below in **Figure 3-4**. This is based upon the year-2025 demand forecast of the WLRP project; the demands do not include those of local distribution systems that are served entirely by local wells rather than the transmission system.

Figure 3-4 Water Demands Sorted by Elevation of Local Service Reservoirs



Approximately 30% of the total water demand is associated with the major reservoir, Zubdat, located in Irbid at Elevation 625m. About 70% of the water demand can be served by reservoirs at elevations between 500m and 800m; about 10% of the demand is at low elevations ranging from 365m to 500m, while 20% of the demand occurs at high elevations ranging from 800m to 1190m.

3.4 Analysis of GIS Database

The origin of the GIS database was the information collected by SOGREAH and SAFEGE starting in 1997, which consisted of two parts: the base map and the network data. These were documented in AutoCAD files.

The source for the base map was primarily the Ministry of Municipalities and Rural Affairs, supplemented by as-built drawings of water facilities from the water authority, and verified as necessary by field surveys, interviews and help from WAJ operation and maintenance staff.

Under the OMS (Operations Management Support) project, the AutoCAD files were converted into GIS coverages, and the maps and database have been updated continuously to the present time. The structure of the resulting GIS database has several parts, as described below.

Shapefiles[1] for boundaries. Three types of boundaries are included:

- Administrative boundaries at three successively lower levels: governorates, towns and villages, and blocks. The block boundaries are used in mapping the locations of customers, to assist in system maintenance and repairs.
- ROU boundaries: the 10 Regional Operating Units have boundaries that were defined by NGWA.
- Distribution and Resource Zones: these show how each zone is provided with water. **Figure 3-5** shows the distribution zones of NGWA, and **Figure 3-6** shows the resource zones of NGWA.
- Base map boundaries: these include the boundaries of land plots, land use designations, and streets.

Pipe networks. The GIS data for the water network includes the layout of the pipes on the base map, with information about the diameter, material, length, roughness, the ROU area and other properties of the pipes. **Table 3-2** shows the inventory of pipe lengths by pipe diameter and material for the existing transmission system, obtained from the GIS database. **Table 3-3** shows the inventory of pipe lengths by diameter and material for the entire network, by ROU service area. **Table 3-4** shows the pipe lengths by diameter and material for the entire network, and **Table 3-5** shows pipe lengths by diameter for each ROU.

Topographic contours. Elevation contours at 20m intervals are available for all of the NGWA area, with the exception of North Badia and the southern part of Mafraq. The project team used the spot elevations from the SAFEGE report to produce contours using the spatial analyst (an ArcGIS extension).

Water supply facilities and fittings. The GIS maps and database include information on the following types of equipment and fittings:

- System flow meters: flows are measured at wells and many other locations of flow transfer in the system. The database on each meter includes the type, status, diameter, manufacturer, pressure rating and other properties. **Table 3-6** shows the number of meters by functional type (transmission, import, export, etc.) and status (active, abandoned, planned). **Figure 3-7** shows the locations of the bulk meters at transfer points and flow monitoring points in the transmission system.
- Facilities: these include a broad range of items (wells, reservoirs, pump stations, offices, repair shops, etc.) and attributes of each facility. **Table 3-7** shows an inventory of the number of NGWA facilities by type of facility. The active facilities are shown subsequently on **Figures 3-8** and **Figures 3-8a** through **Figure 3-8d**.
- Control valves: these include air release, altitude, check and pressure reducing valves; the database includes the attributes of each valve.
- System valves: these regulate the flow in the NGWA network, and include gate, ball and butterfly valves. **Table 3-8** shows the number of valves by type for each ROU.
- Fittings: these include blind flanges at the ends of pipes, tees and elbows at intersections, with a description of their properties.

Customer data. For each customer, the data include location, water consumption for the last quarter, and the average of water consumption for the past 8 quarters. **Table 3-9** shows the number of customers and total consumption for each ROU. The Daily use per customer reflects the average daily use by family rather than by individual.

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[1] A "shapefile" is the file format that the GIS software uses. Wherever "Shapefile" is mentioned in this report it means a GIS data file.

Table 3-2 Pipe Length (m) by Diameter and Material, Transmission System

Diameter mm	Pipe Material		
	Ductile Iron	Steel	Total
200		9,472	9,472
300		8,817	8,817
400	1,752	46,709	48,461
500		13,810	13,810
600	35,380	81,469	116,849
800	22,986		22,986
Total	**60,118**	**157,388**	**220,396**

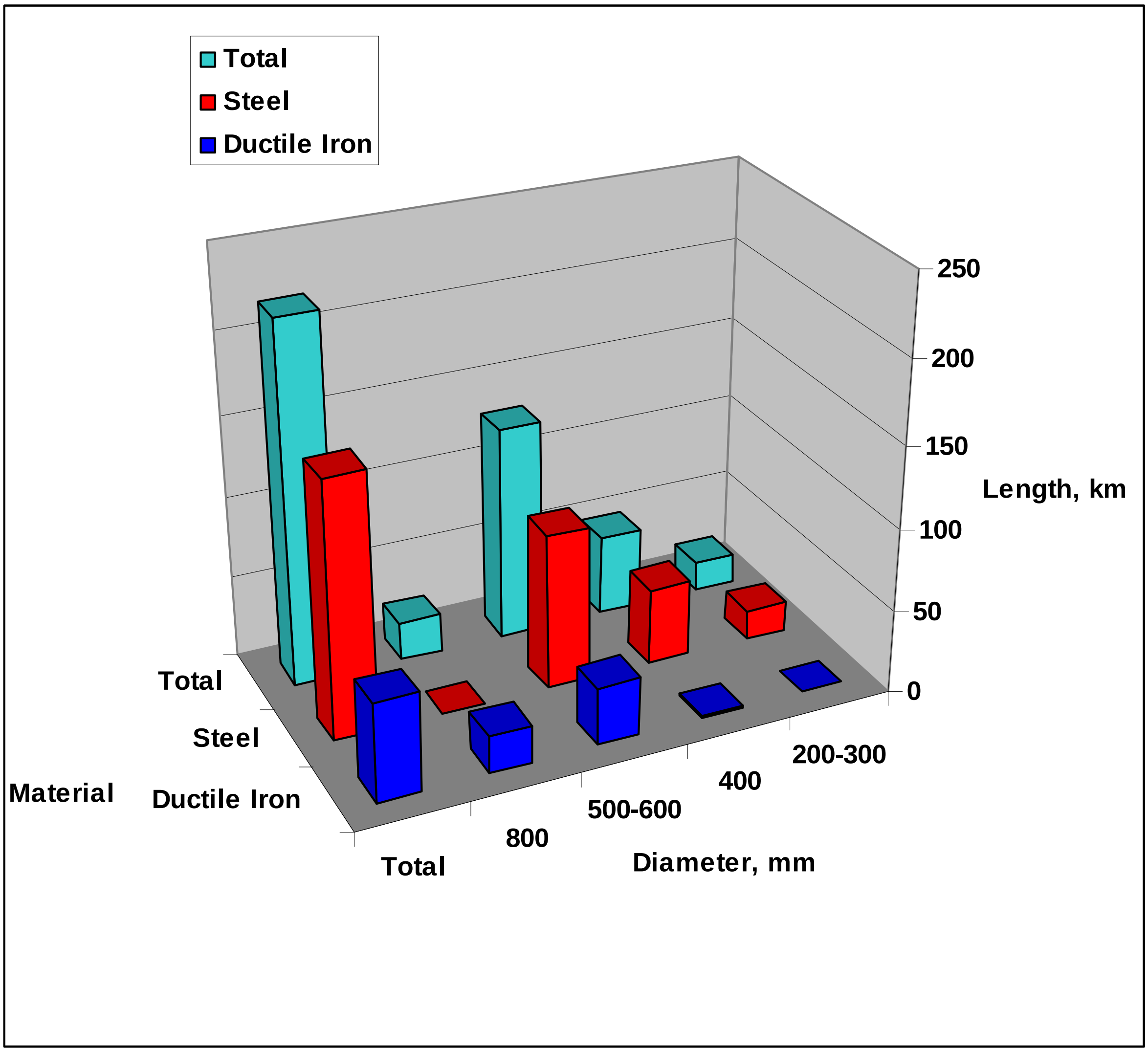

Table 3-3 Pipe Length (m) by ROU, Pipe Material, and Diameter of NGWA Entire Existing Networks

Regional Operations Unit (ROU)	Pipe Material	Pipe Diameter (mm)																
		25	37	50	62	75	100	125	150	200	250	300	350	400	500	600	800	Total
Ajloun	Ductile Iron					34,413	62,157		27,036	5,337		39		2,319				131,301
	Galvanized Iron			1,723		6,363												8,086
	Steel			164,194			74,471	125	38,979	30,329	7,421			6,612				322,131
	Total			165,916		40,776	136,628	125	66,015	35,667	7,421	39		8,931				461,518
Al Koura	Galvanized Iron			109,324		2,720	4,548											116,593
	Steel	343		5,097	110	2,740	31,851	6,212	15,285	22,395				117				84,149
	Unknown	1,945		15,501		39	861	21	36									18,403
	Total	2,288		129,922	110	5,499	37,259	6,233	15,322	22,395				117				219,145
Bani Kinana	Ductile Iron													636				636
	Galvanized Iron			198,898	1,725	29,210	10,863		1,990									242,686
	PVC			116	839	210	2,973											4,139
	Steel			1,154	141	3,221	56,878		41,384	10,631		1,510		4,458				119,378
	Unknown			348			868		1,636									2,852
	Total			200,516	2,705	32,642	71,583		45,010	10,631		1,510		5,094				369,691
Bani Ubaid	Ductile Iron			3,604					1,732	4,437		8,662				17,078		35,514
	Galvanized Iron		301	147,539		26,956	21,478					202						196,476
	Steel			4,377		888	39,684		11,955	7,465		3,127	2,037	17,710		2,968		90,212
	Total		301	155,520		27,844	61,162		13,687	11,903		11,991	2,037	17,710		20,047		322,202
Irbid	Ductile Iron						30,236		17,213	8,986	958	1,748		2,383		4,694	24,631	90,849
	Galvanized Iron		1,454	425,809		36,940	40,168		7,305									511,675
	Steel			459,626		1,780	246,119		109,414	18,158	2,233	9,700	3,739	23,237	1,429	3,189	736	879,360
	Unknown									22,375	2,723	11,505	292	16,630		4,043	394	57,962
			1,454	885,434		38,721	316,523		133,932	49,519	5,915	22,953	4,031	42,250	1,429	11,926	25,761	1,539,846
Jerash	Ductile Iron			139			2,962			5,589								8,689
	Galvanized Iron			278,105		29,270	48,940											356,316
	PVC						4,802											4,802
	Steel			16,336			132,390		66,715	21,653		4,101						241,194
	Unknown			5,154			3,459			125								8,738
				299,735		29,270	192,552		66,715	27,367		4,101						619,739
Mafraq	Ductile Iron			13,416		493	1,904		7,823	13,287	1,808	4,004		2,855	1,432	1,819		48,841
	Galvanized Iron			306,873		8,010	4,622											319,506
	PVC			170			401			684								1,256
	Steel			109,851		20,521	217,693		120,888	37,913	133	23,593		38,834	18,663	54,550		642,638
				430,311		29,024	224,621		128,710	51,885	1,941	27,596		41,689	20,094	56,368		1,012,239
North Badia	Ductile Iron						3,975		4,160	1,185								9,320
	Galvanized Iron			146,693														146,693
	PVC			1,922		180				103								2,206
	Steel			2,042		19,516	64,203		35,115	59,750	17,749	88		69,336	20,210	10,616		298,625
				150,657		19,696	68,178		39,275	61,038	17,749	88		69,336	20,210	10,616		456,844
Northern Shouna	Clay			21					5,873	20,012		868						26,773
	Ductile Iron			87			3,289		1,734	4,905						17,352		27,367
	Galvanized Iron			49,453		1,249	3,990											54,692
	PVC		39	21,779		24,194	8,306		4,076	8								58,402
	Steel			15,727		1,667	23,126		30,593	4,032	2,605	7,123				4,622		89,495
	Unknown			397		172	421			2,558								3,548
			39	87,463		27,283	39,131		42,276	31,515	2,605	7,990				21,974		260,276
Ramtha	Ductile Iron					436						4,869		3,913				9,218
	Galvanized Iron			57,463	58	62,579	6,202		497		9							126,808
	Steel			56,406		1,922	28,784		45,004	27,676	2,494	5,669		1,295				169,249
				113,869	58	64,937	34,985		45,501	27,676	2,504	10,537		5,208				305,275
Total		**2,288**	**1,794**	**2,619,343**	**2,873**	**315,691**	**1,182,623**	**6,358**	**596,442**	**329,595**	**38,134**	**86,806**	**6,068**	**190,335**	**41,733**	**120,931**	**25,761**	**5,566,776**

Table 3-4 Pipe Length (m) by Diameter and Material, NGWA system

A. Pipe Length

Pipe	Pipe Diameter (mm)																
Material	25	37	50	62	75	100	125	150	200	250	300	350	400	500	600	800	Total
Ductile Iron			17,245		35,343	104,522		59,698	43,727	2,766	19,322		12,106	1,432	40,942	24,631	361,735
Polyvinylchloride		39	23,988	839	24,584	16,482		4,076	796								70,804
Asbestos Cement			21					5,873	20,012		868						26,773
Unknown	1,945		21,399		211	5,608	21	1,672	25,058	2,723	11,505	292	16,630		4,043	394	91,502
Steel	343		14,721		51,621	915,199	6,337	514,698	239,941	32,636	54,911	5,776	161,599	40,301	75,945	736	2,114,762
Polyethylene			820,088	251	634			633	62								821,669
Galvanized Iron		1,755	1,721,880	1,783	203,297	140,812		9,792		9	202						2,079,530
Total	2,288	1,794	2,619,343	2,873	315,691	1,182,623	6,358	596,442	329,595	38,134	86,806	6,068	190,335	41,733	120,931	25,761	5,566,776

B. Cumulative Pipe Length by Pipe Material, Percent of Total "Material" Length

Pipe	Pipe Diameter (mm)																
Material	25	37	50	62	75	100	125	150	200	250	300	350	400	500	600	800	Total
Ductile Iron	0.0%	0.0%	4.8%	4.8%	14.5%	43.4%	43.4%	59.9%	72.0%	72.8%	78.1%	78.1%	81.5%	81.9%	93.2%	100%	100%
Polyvinylchloride	0.0%	0.1%	33.9%	35.1%	69.8%	93.1%	93.1%	98.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100%	100%
Asbestos Cement	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	22.0%	96.8%	96.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100%	100%
Unknown	2.1%	2.1%	25.5%	25.5%	25.7%	31.9%	31.9%	33.7%	61.1%	64.1%	76.7%	77.0%	95.2%	95.2%	99.6%	100%	100%
Steel	0.0%	0.0%	0.7%	0.7%	3.2%	46.4%	46.7%	71.1%	82.4%	84.0%	86.6%	86.8%	94.5%	96.4%	100.0%	100%	100%
Polyethylene	0.0%	0.0%	99.8%	99.8%	99.9%	99.9%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100%	100%
Galvanized Iron	0.0%	0.1%	82.9%	83.0%	92.7%	99.5%	99.5%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100%	100%
Total	0.0%	0.1%	47.1%	47.2%	52.8%	74.1%	74.2%	84.9%	90.8%	91.5%	93.1%	93.2%	96.6%	97.4%	99.5%	100%	100%